SECTION 401

PLANT MIX BITUMINOUS PAVEMENT

401.1 Description. This work shall consist of a mixture of aggregate, filler if needed, and asphalt binder prepared in a stationary bituminous mixing plant in such proportions that the resulting mixture meets the grading requirements of the job-mix formula. One or more courses of the mixture shall be placed, spread and compacted in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the engineer.

401.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Coarse Aggregate	1002.1.1 to 1002.1.3, incl.
Fine Aggregate	1002.2
Mineral Filler	1002.3
Hydrated Lime	1002.4
Asphalt Binder, Performance Graded (PG)	1015

The grade of asphalt binder will be specified in the contract.

401.2.1 The gradation of coarse aggregate shall be such that the total aggregate meets the mixture specified in the contract prior to being fed into the cold aggregate feeders.

401.2.2 Screenings shall be considered coarse aggregate consisting of tough, durable particles of approved quality and shall be free from dirt or other objectionable material. The fraction passing a No. 40 (425 µm) sieve shall be non-plastic.

401.3 Composition of Mixtures.

401.3.1 Gradation of Combined Aggregates. The total aggregate prior to mixing with asphalt binder shall meet the mixture specified in the contract.

Sieve Size	Percent Passing by Weight (Mass)	
	BP-1	BP-2
3/4 inch (19.0 mm)	100	100
1/2 inch (12.5 mm)	80-100	95-100
No. 4 (4.75 mm)	40-65	60-90
No. 8 (2.36 mm)	30-55	40-70
No. 30 (600 µm)	10-30	15-35
No. 200 (75 µm)	4-12	4-12

401.3.2 The combinations of material as required in this section shall meet the gradation requirements specified for the work.

401.3.2.1 If gravel, or if flint chat as produced in the Joplin area, is used, not less than 15 percent nor more than 30 percent crushed stone screenings, or dolomite chat screenings as produced in the Southeast Missouri Lead Belt Area, or not less than 4 percent mineral filler by weight (mass) shall be added as a separate ingredient. Screenings shall have 100 percent passing the 3/8-inch (9.5 mm) sieve.

401.3.2.2 If crushed stone, or if dolomite chat as produced in the Southeast Missouri Lead Belt Area, is used, not less than 15 percent nor more than 30 percent natural siliceous sand, porphyry sand or flint sand of approved quality shall be added as a separate ingredient. Wet bottom boiler slag of approved quality may be used as sand.

401.3.2.3 If porphyry is used, sand as described in Sec 401.3.2.2 or mineral filler may be added to meet gradation requirements.

401.3.2.4 With written approval of the engineer, combinations of gravel, crushed stone, dolomite chat or porphyry, or combinations of flint chat, crushed stone, dolomite chat or porphyry, may be used. Not less than 15 nor more than 30 percent sand as specified in Sec 401.3.2.2 shall be added as a separate ingredient. Each size and type of aggregate shall be added as a separate ingredient. Each size and type of aggregate shall be kept separate and fed through separate calibrated cold aggregate feeders to ensure proper proportioning. No mixture will be approved which contains less than 30 percent of any one type of coarse aggregate in the combination. In addition, all plus No. 8 (2.36 mm) sieve fractions shall contain material from each type of coarse aggregate in the approved combination.

401.3.3 The composition of the mixture shall conform to the following limits by weight (mass):

	Percent
Total Mineral Aggregate	92.0 - 96.5
Asphalt Binder	3.5 - 8.0

401.3.4 At least 30 days prior to preparing any of the mixture on the project, the contractor shall obtain in the presence of the engineer representative samples of asphalt binder and mineral aggregates for tests. The samples of the material shall be of the size specified by the engineer and shall be submitted to the Central Laboratory for testing. The contractor shall also submit for the engineer's approval a job-mix formula for the mixture to be supplied for the project. No mixture will be accepted for use until the job-mix formula for the project is approved by the engineer. The job-mix formula shall be within the gradation range for the grade specified and shall include the type and sources of all material, the gradation of the aggregates, and the relative quantity of each ingredient and shall state a definite percentage for each fraction of aggregate. No job-mix formula will be approved which does not permit within the limits specified in Sec 401.3.1 and 401.3.3 the full tolerances specified in Sec 401.3.6 for asphalt binder and not less than 1/2 the tolerances designated for material passing the No. 8 (2.36 mm) sieve and the material passing the No. 200 (75 µm) sieve. The job-mix formula approved for the mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results or other conditions make it necessary or should a source of material be changed, a new job-mix formula may be required.

401.3.5 The engineer will make such changes in the proportions of asphalt binder and aggregates as considered necessary. The proposed mixture will be compacted and tested in the laboratory in accordance with AASHTO T 167 or AASHTO T 245 at the option of the engineer and modified as follows. The test method used shall be modified by aging the mixture for two hours, at the specified compaction temperature range of the asphalt binder, just prior to compaction of the specimens. The mixture of mineral aggregate and asphalt

binder shall result in a bituminous mixture which will be durable and retain satisfactory cohesion in the presence of moisture.

401.3.5.1 Moisture susceptibility may be tested in accordance with AASHTO T 283 or AASHTO T 165, at the option of the engineer. A minimum retained strength of 70 percent shall be obtained when tested for moisture susceptibility. If requested by the contractor, hydrated lime may be added to increase retained strength to a passing level.

401.3.5.2 The minimum voids in the mineral aggregate (VMA) shall be as listed below. The engineer may make adjustments in the job-mix formula submitted by the contractor in order that 60 to 80 percent of the VMA are filled with asphalt binder. Approved mixtures, when compacted and tested in the laboratory in accordance with AASHTO T 167 or AASHTO T 245, shall have an air void content within the range listed below, when calculated from a voidless mixture composed of the same material in like proportions.

401.3.5.2.1 Mixtures shall have a minimum stability as listed below, when tested in accordance with AASHTO T 167.

Percent Air Voids	**AASHTO T 167 Modified, Stability PSI (kPa)**	**Voids in Mineral Aggregate (VMA)**
3.0-6.0	300 (2100)	15.0

401.3.5.2.2 Mixtures shall have a minimum stability as listed below, when tested in accordance with AASHTO T 245. The number of blows with the compaction hammer shall be 50.

Percent Air Voids	**AASHTO T 245 Modified, Stability lb (N)**	**Voids in Mineral Aggregate (VMA)**
3.0-6.0	750 (3350)	15.0

401.3.6 Gradation Control. In producing mixtures for the project, the plant shall be so operated that no intentional deviations from the job-mix formula are made. Mixtures as produced shall be subject to the following tolerances and controls:

(a) The total aggregate gradation shall be within the master range specified in Sec 401.3.1 for the mixture specified.

(b) The maximum variation from the approved job-mix formula shall be within the following tolerances:

Passing No. 8 (2.36 mm) sieve	±5.0 percentage points
Passing No. 200 (75 µm) sieve	±2.0 percentage points

(c) The quantity of asphalt binder introduced into the mixer shall be that quantity specified in the job-mix formula. No change may be made in the quantity of asphalt binder specified in the job-mix formula without written approval of the engineer. The quantity of asphalt binder determined by calculation or tests on the final mixture shall not vary more than ± 0.5 percentage point from the job-mix formula.

401.3.7 The gradation of the aggregate will be determined from samples taken from the hot bins on batch type or continuous mixing plants or from the composite cold feed belt on drum mix plants. Batch-type or continuous mixing plants shall have a screening unit which

separates the usable heated aggregate into at least two sizes. One of the aggregate bin sizes produced by the screening unit shall contain not more than 10 percent by weight (mass) retained on the No. 4 (4.75 mm) sieve.

401.3.8 Commercial Mixture. If designated in the contract that an approved commercial mixture may be used, the contractor shall, at least seven days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture the contractor proposes to furnish. The statement shall include: (1) the types and sources of aggregates, percentage range of each and range of combined gradation; (2) the percent and grade of asphalt binder; and (3) the mixing time and range of mixture temperature. The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. It will not be necessary for the plant to meet the requirements of Sec 401.6. A field laboratory will not be required. If the proposed mixture and plant are approved by the engineer, the component material and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with the first truck load of each day's production, a certification in triplicate that the material and mixture delivered are in conformance with the contractor's approved proposal. Upon completion of the work, plant certification in triplicate shall be furnished by the supplier for the total quantity delivered. The mixture shall be transported and placed in accordance with the requirements specified in Sec 401.8 through 401.13 and shall be compacted as specified in Sec 401.12.

401.3.8.1 Without specific contract designation, an approved commercial mixture meeting the requirements of Sec 401.3.8 may be used in lieu of plant mix bituminous pavement mixtures for work that is considered temporary construction and is to be maintained at the contractor's expense. Temporary construction is work that is to be removed prior to completion of the contract. In addition, an approved commercial mixture may be used for the 2-foot (600 mm) wide shoulder edge strip adjacent to the traveled way.

401.4 Field Laboratory. The contractor shall provide a Type 3 Field Laboratory meeting the requirements of Sec 601. No direct payment will be made for providing the laboratory.

Construction Requirements

401.5 Weather Limitations. Bituminous mixtures shall not be placed (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F (10 C), (2) on any wet surface or frozen pavement, or (3) when weather conditions prevent the proper handling or finishing of the mixture. Temperatures shall be obtained in accordance with MoDOT Test Method T20.

401.6 Bituminous Mixing Plants. Bituminous mixing plants and preparation of material and mixtures shall conform to the requirements of Sec 404.

401.7 Subgrade Preparation. The subgrade upon which bituminous mixture is to be placed shall be prepared in accordance with Sec 209 and tacked or primed, as specified in the contract, in accordance with Sec 407 or 408, as applicable.

401.8 Hauling Equipment. Trucks used for hauling bituminous mixtures shall comply with the requirements of Sec 404.

401.9 Spreading. The base course, primed surface or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign material prior to spreading the bituminous mixture. When placed on the roadbed, the mixture shall have a temperature of not less than 260 F (127 C). It shall be spread with an approved spreading and finishing machine in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. The paver shall be operated at a speed that will give the best

results. The rate of delivery of the mixture to the paver shall be coordinated so as to provide, where practicable, a uniform rate of placement without intermittent operation of the paver. The compacted thickness of a single layer shall not exceed 2 inches (50 mm) for the surface course and 4 inches (100 mm) for the leveling course. The total thickness of the 2-foot (600 mm) wide shoulder edge strip adjacent to the traveled way may be placed in a single layer. On small areas and areas which are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods when permitted by the engineer.

401.9.1 The mixture shall be spread without tearing the surface and struck off so that the surface is smooth and true to cross section, free from all irregularities and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. Areas of segregated mixture shall be removed and replaced with suitable mixture. The outside edges of the pavement shall be constructed to an angle of approximately 45 degrees with the surface of the roadbed. The outside edge alignment shall be uniform and any irregularities shall be corrected by adding or removing mixture before compacting.

401.9.2 Spot Wedging and Leveling Course. Leveling course, consisting of a layer of variable thickness used to eliminate irregularities in the existing surface, shall be spread to the desired grade and cross section. Rigid control of the placement thickness of the leveling course will be required. Spot wedging operations over small areas, with feather-edging at high points and ends of spot areas, may be required prior to placing the leveling course. The use of an approved finishing machine will be required on the spot wedging and the leveling course, except that the spreading of the spot wedging with a blade grader will be permitted if results indicate the mixture is practically free from segregation.

401.9.3 For roadways constructed under traffic, no pavement edge differential shall be left in place for more than seven calendar days, unless approved by the engineer.

401.10 Joints. Longitudinal and transverse joints shall be carefully made and well bonded. Transverse joints shall be formed by cutting back on the previous run so as to expose the full depth of the layer. When a transverse vertical edge is to be left and opened to traffic, a temporary depth transition shall be built as approved by the engineer. A single lane of any layer shall not be constructed to a length for which the adjacent lane cannot be completed the succeeding operating day. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches (150 mm); however, the joints in the final layer shall be at the lane lines of the traveled way, except that the placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint.

401.11 Surfaced Approaches. At locations designated in the contract or as specified by the engineer, approaches shall be primed in accordance with Sec 408 and surfaced with a plant mix bituminous mixture. The bituminous surface shall be placed in accordance with the details shown on the typical section or as specified by the engineer. Approaches shall not be surfaced until after the surface course adjacent to the entrance is completed. No direct payment will be made for any work required to condition and prepare the subgrade on the approaches.

401.12 Compaction. Rolling shall begin after spreading the mixture as soon as it will bear the weight (mass) of the roller without undue displacement. All rollers shall be in satisfactory condition capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Rollers shall have a system for moistening each roll or wheel. The compacted mixture shall have a density of not less than 95 percent of that obtained by the laboratory compaction of a specimen made in the proportions of the approved mixture. Density will be determined by the direct transmission nuclear method in accordance with MoDOT Test Method T41 or by a specific gravity method.

401.12.1 In lieu of roller and density requirements, mixtures used for shoulders, temporary by-passes to be maintained at the expense of the contractor, and areas where a commercial mixture is used shall be thoroughly compacted by at least three complete coverages over the entire area with a pneumatic tire roller not less than 10 tons in weight (10 Mg in mass), a tandem-type steel wheel roller not less than 10 tons in weight (10 Mg in mass) or an approved vibratory roller. Rolling shall be performed at proper time intervals on each layer and shall be continued until there is no visible evidence of further consolidation and until all roller marks are eliminated.

401.13 Surface Tolerances. The finished courses shall have the nominal thickness shown on the plans and shall be substantially free from waves or irregularities. The final riding surface, except on medians and similar areas, shoulders, and temporary by-passes shall not vary from a 10-foot (3 m) straightedge, applied parallel to the centerline, by more than 1/8 inch (3 mm). At transverse construction joints, the surface of all other layers shall not vary from the 10-foot (3 m) straightedge by more than 1/4 inch (6 mm). Surfaces exceeding these tolerances shall be re-rolled, replaced or otherwise corrected in a manner satisfactory to the engineer.

401.13.1 The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture showing an excess of asphalt binder or that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with satisfactory mixture, which shall be immediately compacted to conform with the surrounding area.

401.14 Testing Pavement. During construction, the engineer will make as many tests as are necessary to ensure that the course is being constructed of proper thickness and composition. The contractor shall cut samples of the compacted mixture from any course at locations designated by the engineer and shall deliver them to the field laboratory in good condition. Samples may be obtained by either sawing with a power saw or by drilling 4-inch (100 mm) diameter cores. Each sawed sample shall consist of a single piece of the pavement of the size designated by the engineer but not larger than 12 inches (300 mm) square. Each cored sample shall consist of four cores. All samples shall be taken the full depth of the layer to be tested and shall consist of an undisturbed portion of the compacted mixture. The surface from which samples have been taken shall be restored by the contractor not later than the next day of plant operation.

401.14.1 After construction is complete, the engineer will require samples to ensure that the total thickness of the completed pavement is acceptable. The contractor shall obtain samples for total compacted thickness of all layers, including any bituminous base or leveling courses, at locations designated by the engineer. Each sample shall consist of one 4-inch (100 mm) diameter core taken the full depth of bituminous construction. The surface from which samples have been taken shall be restored by the contractor within 48 hours using an approved commercial or "cold patch" mixture acceptable to the engineer.

401.15 Pavement Marking. If the contractor's work has obliterated existing pavement marking on resurfacing projects open to through traffic, the pavement marking shall be replaced in accordance with Sec 620.

401.16 Method of Measurement. The weight (mass) of the mixture will be determined from the batch weights (masses) if a batch-type plant is used, and will be determined by weighing (by determining the mass of) each truck load on scales conforming to the requirements of Sec 310.4.3 if other types of plants are used.

401.16.1 Measurement of asphalt binder, to the nearest 0.1 ton (0.1 Mg) for the total tonnage used in the accepted work, will be determined by the use of the job-mix formula applied to the weight (mass) of accepted mixture of mineral aggregate and asphalt binder.

401.16.2 Measurement of the weight (mass) of mineral aggregate, to the nearest ton (megagram), will be determined by subtracting the weight (mass) of the asphalt binder from the weight (mass) of the mixed mineral aggregate and asphalt binder.

401.17 Basis of Payment. The accepted quantities of plant mix bituminous pavement will be paid for at the unit price for each of the pay items included in the contract. Payment for obtaining and delivering samples of compacted mixture from the pavement and replacing the surface will be made per sample at the fixed unit price specified in Sec 109.14.